

GSP Spotter!
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Do violent tornadoes occur in the
western Carolinas and northeast
Georgia?

It's well known that the Great Plains endure a disproportionate number of the nation's tornadoes. So, it's not surprising that this area of the country also experiences a large percentage of the country's violent tornadoes, defined as tornadoes rated at F4 or F5 on the Fujita Scale. In fact, the 7-state stretch of land from Texas to Iowa and South Dakota, often referred to as "Tornado Alley," endures just over 50% of the nation's violent tornadoes. Considering the fact that this area of the world has a relatively low population density, with vast expanses of undeveloped land, *and* that a tornado must actually hit something to be assigned an F-scale rating, this number is truly impressive. (In other words, there are probably a lot of violent tornadoes that occur, but are not rated as such because they don't hit anything!)

So, why don't the Western Carolinas and northeast Georgia experience as many tornadoes as the Plains? Ask the average person and invariably the response will be "It's so darn flat out there!" Actually, geography has a lot to do with it, but the flatness of the land plays only a small role, if it plays one at all. The actual reason that the Great Plains endures so many violent tornadoes is due to its location with respect to the Gulf of Mexico and the Rocky Mountains. In the spring, low-level southerly winds developing ahead of strong Rocky Mountain storm systems draw rich Gulf of Mexico moisture northward into the Plains. Meanwhile, west and southwest winds at around 10,000 feet blow off the high terrain of the Rockies, carrying a layer of

warm, dry air out over the Plains, which acts as a stable layer that traps the warm, moist Gulf air near the surface. Above the layer of warm, dry air, the atmosphere cools very rapidly with increasing height, which combined with the warm, moist low levels, creates a potentially unstable air mass. However, the stable layer acts as a "lid" on the atmosphere, preventing the release of the instability (i.e., the development of thunderstorms) until some mechanism is able to remove the lid. Meanwhile, since thunderstorms are not able to develop, (and thereby stabilize the atmosphere) solar heating of the earth's surface causes further increase in the potential instability.

The most common mechanism for removal of the stable layer is through lifting processes, especially in association with upper level disturbances. As the layer is lifted, it cools, thus removing the lid. If a cold front or other surface boundary is available to provide a source of low-level lift, the removal of the lid will allow instability to be released in the form of thunderstorms. If these processes occur during the late afternoon (as they often do), storm development can become quite explosive and violent, since the lid allowed strong destabilization to occur throughout the day.

A rare breed of severe thunderstorm known as the "supercell" produces almost all violent tornadoes. All thunderstorms develop due to the presence of atmospheric instability. However, supercell development requires the additional ingredient of strong "wind shear." Wind shear describes the change of wind with height in the atmosphere, both in terms of direction and speed. An atmosphere supportive of supercells typically features winds from the south at 10 to 20 mph at the surface, which change direction and increase gradually with height until they're blowing out of the

west or southwest at 60 mph at about 20,000 feet. Wind shear is typically quite strong during the spring across the region, as the jet stream has yet to begin its seasonal migration to higher latitudes. Therefore, due to the unique geography of the region, strong wind shear and strong instability coexist on a fairly regular basis across the Great Plains during the spring months. The result is often outbreaks of supercell thunderstorms, which can occasionally produce violent tornadoes.

So, why are violent tornadoes so extremely rare in the western Carolinas and northeast Georgia, and across all of the eastern U.S. for that matter? Quite simply, it's much more difficult to achieve the right combination of instability and wind shear in this part of the country than it is in the Plains. When spring storm systems bring strong wind shear to the region, the atmosphere over the Carolinas is often too stable for supercell storms. One reason for this is that as strong storm systems move across and east of the plains, various processes (including thunderstorms) allow moisture to build high into the atmosphere. By the time storm systems reach the Carolinas, the upper levels of the atmosphere are often extremely moist. Whereas low-level moisture is essential for supercell thunderstorms, high-level moisture is often detrimental to their development, as moisture in this region of the atmosphere has a stabilizing effect. Conversely, during the summer months, when strong heating results in an unstable atmosphere on a daily basis, (and thunderstorms become more common) the jet stream has retreated to the northern states and southern Canada, and wind shear is too weak for development of supercells. This is why our severe weather leans so heavily toward the hail and high wind end of the spectrum, as opposed to the tornadic, as most of our severe storms occur in weakly sheared environments.

However, the most dangerous term that one can use when describing weather in the mid-latitudes is "never." Violent tornadoes are extremely rare events in the Carolinas and Georgia, but they are certainly not unheard of. Even in this part of the world, supercell thunderstorms occur on a handful of days every year. Occasionally, these storms do produce violent tornadoes. The last violent tornado that occurred in the western Carolinas was on 7 May 1998, when an F4 struck the Dudley Shoals area of Caldwell County, NC. Fortunately, this tornado tracked only a short distance, but damaged or destroyed several mobile homes, and destroyed one well constructed home along its 4-mile track. It was also responsible for 2 injuries. Prior to that, an outbreak of F4 tornadoes occurred across the western Carolinas on 5 May 1989. These tornadoes were responsible for 7 fatalities, 93 injuries, and 17.5 million dollars in property damage. One of the tornadoes tracked across rural areas of Union County, NC, but still produced 8 million dollars in damage and caused 7 casualties, including 1 fatality. If this tornado had developed only 20 miles to the northwest, it would have torn through the heart of the Charlotte metro area, and the casualties and property damage figures would have been staggering.

Violent tornadoes also occurred across the region in 1973, 1944, and 1920. It's only a matter of time before another violent tornado affects the region. The season for violent tornadoes is now upon us, as all previous events have occurred in the time period between late March and early May. It is important that storm spotters, meteorologists, and emergency managers maintain awareness of the fact that violent tornadoes, although extremely rare, are inevitable in this part of the country.

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